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Analysis of Difficulty of Science Learning-Based Multi-Representation

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Abstract – This study aims to: (1) describe the physics learning difficulties of students of class VIII in the Junior High School 1 Pomalaa.; and (2) describing any factors that cause learning difficulties Physics learners in class VIII Junior High School 1 Pomala. Subjects in this study were all learners VIII_A class and VIII_D Junior High School 1 Pomalaa the second semester with the topic learning in motion and force. The research instrument consisted of multi-representation ability tests and interviews and then analyzed descriptively using a quantitative approach. Data analysis results obtained: The ability of multi-representation of students in the topic of motion and force is still relatively low with an achievement percentage of 71.86%. Learners are in a low category had a pattern of learning difficulties in understanding about the language, understand the basic concepts, analyze the image, determine the y-axis and the axis s, define symbols, set the equation and the difficulty in calculating. Learners medium category with a percentage of 27.35% achievement patterns of learning difficulties in understanding the basic concepts, force projection, determine the y-axis and s, erroneously define symbols, and erred in the calculation. Learners higher category has a pattern of learning difficulties in analyzing the image and determines the y-axis and the axis s on the graphical representation.

Keywords: Learning difficulties, Multi-representation, Motion, Force.

I. INTRODUCTION

Science is a clump of science that has a particular characteristic that is studying natural phenomena factual, reality or events and the causal relation [1]. Current branches of science which include members of the Natural Sciences group include Biology [2], Physics, Natural Sciences, Astronomy, and Geology [3]. Science learning is the interaction between the components of

learning in the learning process to achieve competence in the form of a predetermined [4], [5].

Based on the results of interviews conducted by researchers to a science teacher (Physics) class VIII at Junior High School 1 Pomalaa obtained information that: (1) There are currently many learners with learning difficulties, it is known from the average score of the study of students in class VIII of 45 do not meet the standards of KKM

(Indonesia Named completeness criteria minimum) at 65. (2) Then, the lack of involvement of students in the learning process that makes students have difficulty in representing abstract concepts of Physics. (3) Students tend only to be able to explain the definition of an idea but cannot provide quantitative problem solving, and cannot explain in the form of pictures or graphics. It indicates a lack of ability to multi-representation of participants that have difficulties resulting in low yields of learners.

Seeing this phenomenon, the researcher tries to assess the difficulties of student learning. Researchers take the topic of motion and force because motion and force contain all elements of multi-representation. As reported by Furwati et al. [6], that is the subject of motion and force requires students to think critical because it includes many multi-representation elements. So students can understand the concept well. Next Beichener [7] said that in the topic of motion and force, many aspects of the picture hang, graphical analysis, thoughts, verbal analysis. So that students better understand more about the idea given.

Furthermore, Uslima [8] reports that by using multi-representation can analyze student learning difficulties on the topic of fluid. While Kusumawati et al.[9]; Fatmaryanti et al.[10]; Dimas et al.[11]succeeded in explaining the challenge of learning physics based on multiple representations on the subject of elementary

physics, magnetic field, & simple harmonic motion. Haili et al.[12] suggest that multi-representation is useful in analyzing student learning difficulties.

Learning difficulties can be interpreted as a condition in a learning process that is marked by certain obstacles to achieve learning outcomes. Students with low ability do not only experience learning difficulties, but also experienced by students with high knowledge [13]–[15]. One way to know the challenges of learners is to analyze the results of answers to such learners. The Physicists usually use various representations to simplify the process of analysis and explanation of matters related to the concept of Physics [16]. Multi description means re-representation (something the same thing) with different formats, in the form of verbal, drawings/diagrams, graphs, and mathematics [16]. while the ability of multi-representation is the ability to apply various representations in explaining physics concepts and problems in physics[17].

In science learning, there are topics about physics; one of the main topics in physics is motion and force. Where the subject of motion and force is one of the issues that require multi representations in solving problems and involves the development of multi representational abilities verbally, drawings/diagrams, graphs and mathematics so that students are not only required to memorize formulas. In this line with research conducted by Theasy [18] in

his study finding that the multi-representation ability of high, medium and low category students tends to represent mathematically sequentially at 67.85%, 79.92%, and 75 %.Learners more top category has a pattern of learning difficulty understanding the language matter physics, define and determine the stage of completion and equality.

Learners medium typically have a model of learning difficulties in understanding the language problem, determine the solution, force projection, identify the components of the force acting on the object, to determine the equation, application, and calculations. Learners lower category has a pattern of learning difficulty understanding the language matter physics, to determine the equation, distinguishing symbols of physics, applying equations, calculations and does not perform checks and evaluate. Then Yuliana [19] in a study stating that the verbal representation of students on average by 85.8%, the description of images of students on average by 64.7%. Then the mathematical representation of students with an average of 80.8%, from the third representation of students is high, which is a numerical representation of students. Student difficulties in verbal representation because the students are not able to redefine the purpose about, in image representations students cannot draw pictures of problem information. In contrast, mathematical

representations students cannot determine the formula to be used.

Based on the description that has been described and by looking at the conditions that occur in the school. So researchers are interested in conducting a study entitled analysis of physics learning difficulties for students of class VIII based on the ability of multi representation on the topic of motion and force in Junior High School 1 Pomala.

Problem of Study

The problems that will be examined in this study are as follows:

1. How is the difficulty of learning Physics for grade VIII students based on the ability of multi-representation in the material of Motion and Force at Junior High School 1 Pomala?

What are the factors that cause learning difficulties learners Physics class VIII based on the ability multi representation on the topic Motion and Force in the Junior High School 1 Pomala?

II. LITERATURE REVIEW

A. Learning

Learning can be interpreted as a change in people's behavior because of interaction between people and the environment so that they can communication and good with their environment. It means that a person undergoing the learning process will experience a shift in actions as regards both his awareness, skills and attitude. [20].

Behavioural changes from incomprehension to comprehension, from foolish to intelligent; from being unable, from unskilled to qualified is an aspect of skill; It is a matter of hesitating to know from rude to courteous, from bash to experienced in attitude. It is one of the criteria for learning success, which is marked by improvement in the way people learn.. Learning may be assumed to be failing or improving without behavioural changes. [21]

B. Nature of Science

Science is an ensemble of information, with a particular nature that studies both the facts or the events and their causal relationships in natural phenomena that are empirical. Present scientific areas include biology, physics, chemistry, astronomy, and geology, among them representatives of the natural sciences[22].

Science is an experimental knowledge that was originally obtained and developed, but science is often obtained and created on the basis of a hypothesis (deductive) in future changes [23]. There are three terms involved in science, namely "science", "knowledge", and "nature". Knowledge is everything that is known to humans being. Awareness of religion, education, health, economics, politics, culture and nature is an indication of people's knowledge. Knowledge of nature means knowledge of the universe and its contents. Trust, curiosity, creativity, reasoning, correction are natural modes of thought [24], [25].

C. Difficulty learning

Difficulty is a certain condition which is marked by the obstacles in the activities to reach the goal, so it requires even more active efforts to be able to overcome [26]. Learning difficulties can be interpreted as a condition in a learning process that is marked by certain obstacles to achieve learning outcomes [27].

Factors that cause learning difficulties are related to brain malfunction. The lack of support of the feelings (emotions), family factors, teachers, schools, mass networks and social environment for children, neural organization and other parts of the body [28].

Learning difficulties are conditions that refer to a number of disorders that affect the acquisition, organization, storage, understanding and use of information verbally and nonverbally. As a consequence of this situation, it is difficult for individuals with learning disabilities to work as disorders associated with learning disability usually impair the functioning of mental functions. [29]

D. Multi-representation

According to Prain & Waldrup [16], multi representation means the re-representation of the same concept with different formats including verbal, image, graphic and mathematical. Multirepresentation ability is the ability to apply various representations in explaining Physics concepts and problems in Physics [17], [30]. In Physics many types of representations can be raised.. Types include:

verbal description, drawings/diagrams, graphs, mathematical [31].

III. METODE PENELITIAN

This type of research is descriptive research with a quantitative approach. The population in this study are all students of class VIII in the Junior High School 1 Pomalaa totalling 154 people consisting of class VIII_A, VIII_B, VIII_C, VIII_D and VIII_E. The sampling technique used in this research is purposive sampling technique with particular consideration to see the lowest average score. The sample used in this research is class VIII_A and VIII_D by the number of students as many as 64 people. Data collection techniques in this research are using test completion questions and

interview tests. The data obtained are analyzed and given a score according to the scoring rubric presented by Etkina et al. [32]. To assess the ability of multi representation-learners are given a score ranging 0-3. A score of 0 (lost) given to students who cannot form a blank description or answer, a score of 1 (inadequate) indicates some information is not displayed on the image made by students or contains a significant error. A score of 2 (needs improvement) shows that the description of students already represents most or all of the information presented but still less clear. Score 3 (adequate) means that all-important information displayed on the image in the form of, organized and clear.

Table 1. Assessment Rubrics to Assess Student Data Presentation [32]

Scientific Ability	Score 0 (lost)	Score 1 (Inadequate)	Score 2 (Needs improvement)	Score 3 (Adequate)
Able to record and represent data in a meaningful way	Data missing or incomprehensible	There are no relevant data available or cannot be understood	All the important data exist but require effort to understand	All important data is presented, organized and recorded clearly

After obtaining the test results, then calculate the ability of each student with the formula:

$$X = \frac{n}{N} \times 100\% \quad (1)$$

Where,
X: Student ability level,
n: Score obtained by students,
N: Maximum score

After obtaining the ability of each student, then determine the average ability level using average analysis with formulas:

$$\bar{x} = \frac{\sum x}{f} \times 100\% \quad (2)$$

Where,
 \bar{x} : Average ability level of the students, *x*:
The level of ability of each student,
f: Total number of students

To determine the ability of multi representation category of learners measured based on a scale of types of knowledge as shown in Table 2 [33].

Table 2.Category Scale-Ability Learners

Value	Ability Category
$x > 75\%$	High
$45\% \leq x \leq 75\%$	Medium
$x < 45\%$	Low

IV. RESULTS AND DISCUSSION

A. Results of Research

1. Overview of Multi-Representative Students' Capability

Data the ability to multi-representation of students of class VIII in the Junior High School 1 Pomala obtained from answers learners VIII_A class and VIII_D and in terms of the tendency of using multi-representation of students in solving problems of motion and force of four types of representation namely verbal, drawing/diagram, graphic, and mathematical. The multi-representation ability of students in general at Junior High School 1 Pomala presented in Table 3.

Table 3.The Ability to Multi-Representation of Students In General

No	I	X	Category	No	I	X	Category
1	P-1	40	Low	33	P-33	46,7	Medium
2	P-2	46,7	Low	34	P-34	46,7	Medium
3	P-3	40	Low	35	P-35	33,3	Low
4	P-4	33,3	Low	36	P-36	33,3	Low
5	P-5	40	Low	37	P-37	33,3	Low
6	P-6	66,7	Medium	38	P-38	33,3	Low
7	P-7	40	Low	39	P-39	40	Low
8	P-8	53,3	Medium	40	P-40	46,7	Medium
9	P-9	26,7	Low	41	P-41	40	Low
10	P-10	40	Low	42	P-42	46,7	Medium
11	P-11	46,7	Medium	43	P-43	40	Low
12	P-12	33,3	Low	44	P-44	40	Low
13	P-13	40	Low	45	P-45	46,7	Medium
14	P-14	33,3	Low	46	P-46	40	Low
15	P-15	46,7	Medium	47	P-47	53,3	Low
16	P-16	53,3	Medium	48	P-48	33,3	Low
17	P-17	46,7	Medium	49	P-49	33,3	Low
18	P-18	46,7	Low	50	P-50	40	Low
19	P-19	33,3	Low	51	P-51	60	Medium
20	P-20	40	Low	52	P-52	40	Low
21	P-21	40	Medium	53	P-53	40	Low
22	P-22	33,3	Medium	54	P-54	46,7	Medium
23	P-23	40	Medium	55	P-55	33,3	Medium
24	P-24	40	Low	56	P-56	33,3	Low
25	P-25	46,7	Medium	57	P-57	40	Low
26	P-26	33,3	Low	58	P-58	46,7	Medium

27	P-27	40	Medium	59	P-59	53,3	Medium
28	P-28	33,3	Low	60	P-60	46,7	Medium
29	P-29	33,3	Low	61	P-61	40	Low
30	P-30	46,7	Medium	62	P-62	46,7	Medium
31	P-31	40	Low	63	P-63	33,3	Low
32	P-32	40	Low	64	P-64	33,3	Low
Total						Low	38 Student
						Medium	26 Student
*I= Initials of Respondents, X: Student ability level							

There are four types of representations to solve problems of motion and force are verbal representation, the description of images, graphic illustrations and mathematical representation. The following (Table 4) are the results of an analysis of the multi-representation ability of students in four types of representation, as well as

learners acquire the data corresponding assessment rubric score is a score of 0-3 to determine how well learners form of the image exists because each section describes the differences in quality of representation in the form of learners. As for the ability profile of students from four types of symbol can be displayed in Table 4.

Table 4. Profile of Student's Multi-representation Ability

T	No. Question	N				M	MRA
		0	1	2	3		
Verbal	Force	1	0	30	34	0	170/192
	Newton III Law	3	0	57	6	1	44,2%
Image	Force	5	2	58	4	0	66/192
Graph	GLBB	4	1	57	6	0	34,3%
Matematis	GLB	2	1	36	26	1	69/192
*Note: T= Types of Representation & Motion and Force, N= Number of Students Receiving, M= Maximum Score, MRA= Multi-Representation Ability (%) Scores, GLBB (Straight Motion Irregular); GLB (Straight Motion Regular)							

Based on Table 4 shows that the percentage of achievement of the four types of representation is still far from the expected maximum score. It is a relatively low percentage achieved when classified in categories [33]. Moreover, many students who earn a score of 3 (adequate) for two people from 64 learners, namely the verbal and mathematical representation. It shows

that there are still many severe difficulties in representing the issues regarding motion and force.

Rata-rata the ability of multi representation of class VIII students on the topic of movement and force in Junior High School 1 Pomalaa can also be seen in Figure 1.

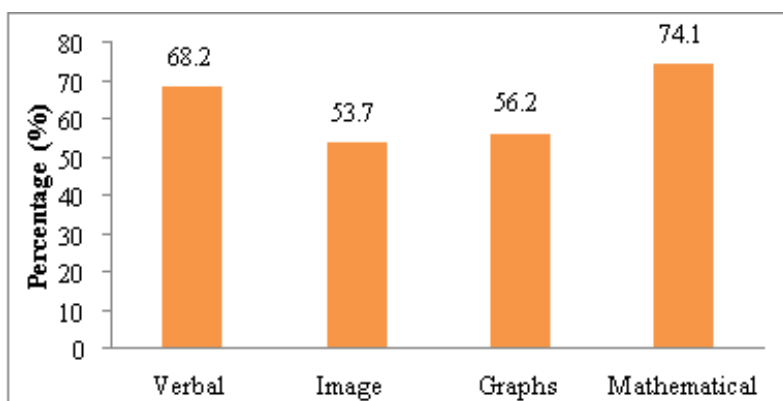


Figure 1. The Average Results for Multi-representation Ability of Students

Based on Figure 1, it can be seen that the average multi-student representation ability is 69.20% in verbal representations, 53.70% in image representations, 56.20% in graphic depictions and 74.10% in mathematical representations. It explains that the average

learners are more likely to use the type of accurate representation. here are presented in Table 5 the results of the analysis of multi representation capability category of learners from four kinds of descriptions to solve problems of motion and force.

Table 5. Categories Multi-Representation of Students

Type of Representation	Category of Ability (%)		
	High	Medium	Low
Verbal	1,56%	53,13%	45,31%
Image	0%	6,25%	93,75%
Graph	0%	9,40%	90,60%
Mathematical	1,56%	40,63%	57,81%
Average	0,78 %	27.35%	71,86%

Based on Table 5, it can be seen that of the three categories, the verbal representation of students is mostly in the medium category with a percentage of 53.13%. For image representation most students are in the low category with a percentage of 93.75%, the most graphic illustration of students is in the low grade with a percentage of 90.60%, and for the mathematical representation of students, the most are in the low category with a percentage of 57.81%. It showed the most significant learning difficulties

experienced by learners, namely the representation of the image.

2. Overview Causes trouble Studying Physics-Based Multi Representation Ability of Students.

Data on factors causing learning difficulties for students were obtained through interviews with each representative of the category of students' multi-representation ability. Here is presented the results of interviews with the learners.

a. Verbal Representation

Verbal representation is in question number 1, where students are asked to explain the force. Here is one excerpt from the interview representatives of learners who are in the low category:

Researcher: Pay attention to question number 3, before you answer this question if you think of when you kick the wall, or you immediately think of the statement Newton's Third Law?

P-51: At the time I read about this, I imagined when kicking the wall when we kick the wall, the wall will give a reaction that causes our feet to hurt, and that immediately reminds me of Newton's Third Law of action-reaction.

Here are excerpts answers learners who obtained a score of 3 (adequate) at a verbal representation.

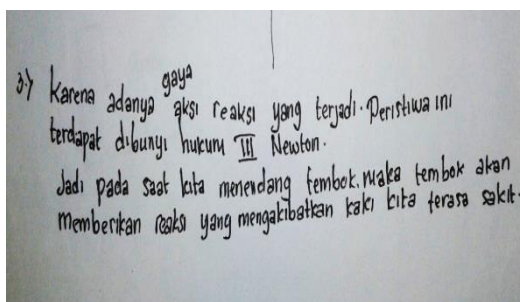


Figure 2. Excerpts of answers of students get a score of 3 on the matter of verbal representation

b. Image Representation

Image representation is in question number 5, where students are asked to describe the projected forces acting on the given image by analyzing the image properly.

Researcher: Pay attention to question number 4, this question asks

you to draw a graph of the speed concerning the time of the statement of the problem, before you answer this question do you analyze the problem well first or you immediately think of the answer?

P-6: I analyze the problem first, and illustrate the graph

Researcher: Then, where are you having trouble?

P-6: I found it challenging to determine which axis v (velocity) and the axis s (time). Then I do not know to continue the answer.

Here are an excerpt answers learners who obtain a score of 2 (needs improvement) in a graphical representation.

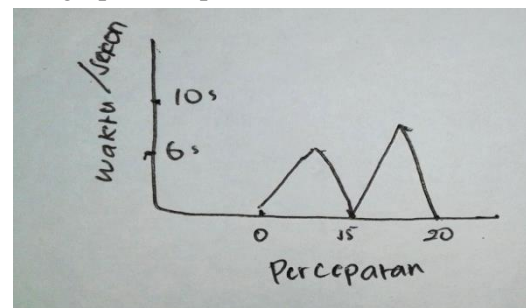


Figure 3. Excerpts of answers of students get a score of 2 on the matter of image representation

c. Mathematical Representation

Mathematical representation of problem number 2, where students are asked to find the distance moved from the car. Here is one excerpt from the interview representatives of learners who are in the low category:

Researcher: Pay attention to question number 2; this question asks you to find the distance moved by car. Before you answer this question if you look at the things that are known in advance or do you immediately think of the formula what should you use?

- P-51: I think about it first then I look for what is known, and I determine the formula.
- Researcher: your answer is almost correct, but there is a slight mistake, that is the solution, are you having a hard time?
- P-51: I have difficulty determining the formula, whether multiplication or division, and the sum process, I do not pay attention to the comma of 0.5, so I get 300 results.

Here is an excerpt answers learners who obtain a score of 2 (needs improvement) in the mathematical representation.

Handwritten student work showing a physics problem solution. The student has written: "Jawab: Dit: $V = 60 \text{ km/jam}$, $T = 0,5 \text{ jam}$. Dit: $g, \dots?$ " and a calculation: $\frac{V}{T} = \frac{60}{0,5} = 60 \times 0,5$, $g = 300$.

Figure 4. Excerpts of answers of students get a score of 2 on the matter of mathematical representation

B. DISCUSSION

The success of learners in understanding a concept and ability to solve the matter of physics necessary to the success of understanding and using multiple representations because in Physics requires multi description in solving the existing problems. According to [17], [34] said that the ability of multi-representation is the ability to apply various images in explaining Physics concepts and problems in Physics.

Based on Table 3 from 64 learners, 38 students are in the lower categories, and 26 learners in the middle grade. It shows that in

general, the ability to multi-representations of learners is still many that are in the low class, which resulted in a great many mistakes in understanding and solving physics problems of motion and force. Table 4 shows that the profile of the participants' ability verbal representation in the topic of by 51%, in the third Newton's Law of matter by 37%, a 34% representation of the image, a graphic representation of 36% and a mathematical representation of 47%. Andromeda [35] reports that most students make mistakes in the problem-solving process because they are not able to involve multi-representations properly. Sujarwanto [36] found several students' difficulties making physics representation, while Rahman [37] found many students are not able to communicate with both the concepts of physics in verbal form.

From this profile, it is known that students are more likely to be verbal and mathematical representations compared to the description of images and graphics. The trend can also be seen in Figure 3 is known that the average ability of multi representation verbal learners by 69.20%, amounting to 53.70% image representation, a graphical representation of 56.70% and 74.10% of the mathematical description. It shows that students tend to use numerical and verbal solutions when solving problems Physics. It is because the learning system tends to approach mathematical representation and

verbal so that learners are less able to complete the picture and graphic illustration.

According to Figures (2,3,4), multi representation ability learners are then said to have learning difficulties which time learners are not able to understand and use representations to solve the problems contained in Physics. It means that there are barriers that obstacles encountered by learners with obstacles that the learner is said to have difficulty in learning. It is in line with research conducted by Theasy [18] which concluded that the achievement of student learning outcomes that have not been maximized shows that students are still experiencing learning difficulties so multi representations are used to determine the problems possessed by students.

The results of research on verbal representations show students who are in the low category known to students is very difficult to remember the understanding of the style because when learning students do not listen well to the material provided by the teacher. So students are challenging to understand the basic concepts of the content presented and answers students contain a huge mistake. Verbal representation in the category being known can think of the theory first and be able to explain some of the notions of force but is still unclear. It is because to understand a learner's concept relies on memorization that he has. Haratua&Judyanto[38]suggested that many students were successful in solving problems

that were preceded by a visualization process using sketches or diagrams than students who were directly at mathematical resolution. Verbal representation In the high category it is known that students can understand the problem by imagining what felt when our feet kick or act on the wall so the wall will react with the pain we think then the students will remember the sound of Newton's Third Law about the action of the reaction due to students still remember the material given by the teacher about Newton's Third Law.

The results of research on the representation of images of students showed that those in the low category of students claimed not to be able to understand the language of the problem and the difficulty of analyzing an image and not being able to project the force acting on objects. The answers learners contain a considerable mistake; this is because the students have not been given the problem of the image in the learning of physics about motion and force. Learners obtain a score of 0 (missing) for two people from 64 learners. The medium category in image representation is known to be able to analyze the problem first and be able to describe an object that weighs 25 Newton and provides a description of the forces acting on the object but requires an effort to understand the answer. Learners claim to have not been able to answer correctly because they have never gotten the problem solving using pictures where so far they tend to accept issues with mathematical

solutions. Prakoso et al.[39]; Anugraheni [40]; Setyani et al. [41] found when a physics teacher in the learning process much more to explain the problem using a verbal form and work on the issues and give examples of questions more into a mathematical representation than using other representations such as the presentation of images and graphics.

The results of the study on the graphic representation of students showed that those who were in the low category were known when answering students' questions did not analyze the problems well first but immediately thought of the answers. So that learners are not able to determine the position of the axis of v (velocity) to s (time), and the responses obtained contains a huge mistake. Students who get a score of 0 (missing), namely one person from 64 students. Representation of learners who are in the category of being known that the students analyze the problem beforehand and can determine the y -axis (speed) and s -axis (time).

However, it is wrong in its placement; then students find it challenging to continue what must be done so that students are not able to answer correctly. students claim they have never gotten a problem with a graphical solution they are more inclined to the question about the understanding of a concept and a problem with a mathematical solution

The results of research on a mathematical representation of students show

that those in the low category note that students are unable to determine what is known and do not know what symbols are used and are not able to use what formulas to use. It is because students forget the equation, and students often play in class and pay less attention to the teacher when giving lessons. Representation of learners in a middle category is known that it can determine known and what is being asked but erred in using the formula. So the answer is generated not by the desired response is claimed that students find it challenging to use methods incorrectly and adequately also. Furthermore, students in the high category know that before answering questions students analyze the problem first then determine what is known and what is asked after that looking for a formula using the magic triangle that has been taught by the teacher so that the student can determine the method correctly and get the answers successfully.

In addition, one of the factors that affect the problem-solving ability of internal factors, including students' interests, intelligence and cognitive abilities. Meanwhile, from external factors, among others, the learning model / method used, the learning environment created and motivation from the teacher. Moreover, a factor supporting the ability to solve problems is the use of the media used by the teacher during a lesson. Selection of appropriate learning media can stimulate the students so that they

can grow the interest and attention of students during the learning takes place.

Based on the analysis and explanation about the question interview done to the students, found some difficulties and factors causing learning difficulties, among others students, have not been able to understand the basic concepts of motion and force due to when learning takes place students often do not pay attention to the teacher. Another difficulty experienced by students is the difficulty in analyzing an image due to students never being given a problem by solving using image representation. A further challenge that learners are not able to determine the y -axis (speed) and the s -axis (time) on the graph due learners are not able to analyze the questions thoroughly. Next is the difficulty in determining what is known in the problem and not being able to distinguish and identify the symbols contained in Physics, and difficulties in deciding formulas as well as problems in calculations in the completion of mathematical representations, these difficulties arise due to students often not paying attention to the explanations given by their teachers.

V. CONCLUSION

Researchers have succeeded in analyzing the physics learning difficulties of Junior High School 1 Pomala based on multi-representation in the topic of motion and

force. With the conclusion that: The ability of multi-representation of students in the material motion and style is still relatively low with an achievement percentage of 71.86%. Learners who are in the low category had a pattern of learning difficulties in understanding about the language, understand the basic concepts, analyze the image, determine the y -axis and s , determine symbols, set the formula and the difficulty in calculating. Medium category students with an achievement percentage of 27.35% have a pattern of learning difficulties in understanding basic concepts, force projections, determining the v and s axis, mistakenly identifying symbols, and mistaken in calculations. High category students have a pattern of learning difficulties in analyzing images and determining the v and s axes in graphical representations.

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